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(54) Heat Embossed Shoes

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HEAT EMBOSSED SHOES

ABSTRACT OF THE DISCLOSURE

A labor-saving shoe making process provides multilayered, heat embossed, shoe components including a one-piece upper. The components comprise a resilient foam layer and other layers for flexibility, strength and durability. Embossing of the shoe components serves to reduce the thickness of the material, provide sealing of the material, provide form and shape to the shoe, and allow strain control management. The connecting of shoe components is accomplished in part through the use of thermoplastic rivets which are heated and melted by the application of a high frequency field.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A shoe comprising an upper portion formed substantially of resilient foam material sandwiched between inner and outer layers, the upper portion being embossed by melted, depressed regions of the foam.

2. A shoe as claimed in Claim 1 wherein the upper portion has an embossed lasting margin.

3. A shoe as claimed in Claim 1 wherein edges of the upper portion are embossed to seal said edges.

4. The shoe component of Claim 1 wherein the resilient foam material is a porous breathable foam which in the presence of heat and pressure transforms internally to a point that the inner cell wall matrix of the foam becomes viscous, providing sufficient tack to accomplish a bonding within the matrix.

5. The shoe component of Claim 1 wherein embossing of the shoe component provides a predetermined functional design pattern on the shoe component.

6. The shoe component of Claim 1 wherein embossing of the shoe component contributes to specific strain performance factors in the shoe component.

7. The shoe component of Claim 1 wherein the embossing of the shoe component contributes to the maintaining of the proper shape of the shoe component.

8. The shoe component of Claim 1 wherein the shoe component is a one-piece upper.

9. The shoe component of Claim 1 wherein the shoe component is an eyestay overlay.

10. The shoe component of Claim 1 wherein the shoe component is a quarter overlay.

11. A component of a shoe comprising a multi-layered material embossed along the edges of the material, the embossing sealing the layers of the material together at the edge and reducing the thickness of the material in the embossed regions.

12. The shoe component of Claim 11 wherein the multi-layered material includes a layer of porous breathable foam which in the presence of heat and pressure transforms internally to a point that the inner cell wall matrix of the foam becomes viscous, providing sufficient tack to accomplish a monogamous bonding within the matrix.

13. The shoe component of Claim 1 wherein the shoe component is further embossed away from the edges of the material.

14. A shoe comprising an upper portion having back sides, sides and a toe area formed from a single sheet of material, the material being selectively embossed relative to the shoe structure such that depressions embossed in the material help maintain a proper shape of the shoe.

15. A shoe as claimed in Claim 14 wherein the shoe comprises a depression curved about the toe area to separate upper and side portions of the toe area.

16. A shoe as claimed in Claim 14 wherein said upper portion comprises a strap formed between sides of the shoe, the strap having transverse depressions thereacross.

17. A shoe as claimed in Claim 14 wherein said upper portion has a depressed lasting margin.

18. A shoe as claimed in Claim 14 wherein upper edges of back sides and sides of said upper portion are sealed by depressions.

19. A shoe as claimed in Claim 14 wherein the sheet of material comprises a resilient foam layer sandwiched between inner and outer layers.

20. A shoe as claimed in Claim 14 wherein the said upper portion has a depressed lasting margin.

21. A shoe as claimed in Claim 14 wherein upper edges of back sides and sides of said upper portion are sealed by depressions.

22. A shoe comprising an upper portion having back sides, sides and a toe area formed in a single sheet of material, the sheet of material comprising resilient foam material sandwiched between inner and outer layers, the material being embossed by melted, depressed regions of the foam to help maintain the

shape of the shoe, the depressed regions including a lasting margin and upper edges of the back sides and sides.

23. A shoe as claimed in Claim 22 comprising a depression curved about the toe area to separate upper and side portions of the toe area.

24. A shoe comprising a plurality of heat-embossed, multi-layered shoe portions fastened together with a thermoplastic connector, the connector passing through the material of the connected portions and being such that once heated it restricts separation of said materials.

25. A shoe as claimed in Claim 24 wherein the thermoplastic connector comprises a first member having pins which extend through the material being fastened together, and a second member having holes which engage the pins of the first member while they are extended through said material.

26. The shoe of Claim 24 wherein the shoe portions comprise the left and right heel portions of a one-piece upper.

27. The shoe of Claim 24 wherein the multi-layer composition of said shoe portions includes a central layer of porous foam sandwiched between an inner layer and an outer layer.

28. A method of making a shoe component, comprising:

fabricating the shoe component in a desired shape from a multi-layered material; and

embossing the shoe component in select regions, the embossing sealing the layers of the material together at the edge and reducing the thickness of the material in the embossed regions.

29. The method of Claim 28 wherein said embossing of the shoe component comprises embossing with heat.

30. The method of Claim 28 wherein embossing said shoe component comprises embossing with high frequency energy.

31. The method of Claim 28 wherein said shoe component comprises a one-piece upper.

32. The method of Claim 28 wherein said shoe component comprises a multi-layered material having an outer layer, a resilient central layer, and an inner layer.

33. The method of Claim 32 wherein said resilient central layer is a porous foam which when heated melts to a bonding adhesive.

34. The method of Claim 32 wherein said outer layer and said inner layer are tricot.

35. The method of Claim 32 wherein said outer layer and said inner layer are woven cotton.

36. The method of Claim 32 wherein the outer layer comprises leather.

37. The method of Claim 32 wherein said central resilient layer comprises polyurethane.

38. A method of fastening together portions of a shoe, the method comprising:

    aligning the shoe portions with one another in a desired fashion;

    inserting a thermoplastic connector through the shoe portions such that the shoe portions are adjacent one another with the thermoplastic connector passing through each of them;

    subjecting the thermoplastic connector to sufficient energy to melt the thermoplastic connector such that when rehardened, the connector restricts the shoe portions from separating from one another.

39. The method of Claim 38 wherein the thermoplastic connector comprises a first member having pins which extend through the shoe portions, and a second member having holes which engage the pins of the first member while the connector is subjected to the melting energy.

40. The method of Claim 38 wherein the shoe portions comprise the left and right heel portions of a one-piece upper.

41. The method of Claim 38 wherein the shoe portions include a tongue.

42. The method of Claim 38 wherein the shoe portions include a portion formed of a multi-layer material, the material having a layer of porous foam, and heat-embossed depressed regions in the material.

43. The method of Claim 38 wherein the shoe portions include an overlay.

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HEAT EMBOSSED SHOES

Background of the Invention

The process of shoe manufacturing is generally very labor intensive and the most expensive component of the manufacturing process today is labor. For a particular shoe style, after the pattern is made for all sizes and the production schedule of manufacturing steps is determined, the labor-intensive assembly process occurs. The assembly process for a shoe having its specific design and number of pieces begins with the process of cutting the upper material. With a more complicated shoe pattern or with more pieces in the shoe design, more elaborate cutting procedures must be designed to minimize waste of materials.

In a typical shoe manufacturing process, after the upper pieces are cut, they are prepared for stitching in the fitting process. The upper pieces are first marked for stitching. The edges of the pieces that are to be joined to other pieces must be reduced in thickness in the skiving process in which a machine cuts a bevel on the edge of the material on the flesh side, or underside of each piece. Some or all of the upper parts, particularly thick leather uppers, may also need to be reduced in thickness or made more even in thickness by a "splitting" machine. Each of these steps requires handling of the individual upper pieces and skilled manipulation to achieve the desired change in the upper.

After the upper pieces are prepared by skiving and splitting, in a typical process, the interlining is cemented to the upper in the doubling process to add thickness and to improve the comfort and smoothness of the interior of the shoe. This requires careful alignment of the interlining and the upper. To further improve the comfort and to add

strength, the insides of the seams are often "rubbed" to reduce their bulk and then reinforced with fabric tape that is adhesive coated. Similar fabric tape is also often applied to the edges of the uppers that are around the top of the shoe opening. Each of these top edges as well as other visible edges may also have cement applied to them prior to folding them into a narrow fold and heat-cementing or stitching the fold in place to provide a neat appearance to the edge.

If the shoe has eyelets, these are applied by a machine that punches, spaces, and aligns the holes and sets the eyelets in the appropriate place. The eyelets then are laced by a machine with thread so that the piece(s) are held in the correct position in the subsequent steps.

The upper pieces are stitched together after or during the fitting process depending on the manufacturing steps for the particular shoe. The stitching process may be by machine or by hand and may include reinforcement stitching at the front corners in laced shoes and decorative stitching.

In the final segment of the traditional shoe manufacturing process, the uppers are then shaped over a last (a shoe form shaped like a foot). A variety of lasting techniques may be used to assemble the upper and interlining over the last and to fasten them to the insole. In this process the heel, toe and side portions of the shoe upper are pulled into place around the last so that they are in the desired shape of the final shoe product. The shoe upper may then remain in that pulled position for several days to set the shape. Alternatively, the position of the upper may be set by a heat setting process. The bottoms of the shoes are added in the "bottoming" process by cementing, molding

or sewing. Laces are then added and the product is boxed and warehoused.

Summary of the Invention

Provided with the present invention is a component of a shoe comprising a multi-layered material embossed in a manner which serves several functions, including but not limited to closing or sealing of edges, incorporation of functional design or pattern lines to facilitate flexing for contouring to maintain shape, and for strain management. The embossing seals the layers of the material together at the edge and reduces the thickness of the material in the embossed regions. One layer of the multi-layered material is a breathable porous foam which, when subjected to heat, or other forms of fusing energy, becomes viscous to a point that an internal bonding of the foam cell matrix is accomplished.

The shoe component is any one of a number of different elements of the shoe. Possible components include an entire one-piece upper or overlay portions. The shoe component may have embossing away from the edges of the material, such as embossing to facilitate design or pattern. Such embossing serves to control shape and texture of the shoe component, and may additionally serve to provide specific strain performance factors in end use application.

Also provided in the present invention is a method of fastening together portions of a shoe. The method involves aligning the shoe portions and inserting a thermoplastic connector through the material of the shoe portions. The thermoplastic connector is then subjected to sufficient energy to soften the thermoplastic connector. The shape of the connector is then deformed such that when it hardens its

new shape restricts the shoe portions from separating from one another.

The first thermoplastic connector may be inserted through a second thermoplastic member as well as the aligned portions of the shoe. The connector may be subjected to a high frequency electromagnetic field of sufficient energy to melt the two pieces of the connector to the point that they adhere to one another, thus securing the shoe portions together.

Brief Description of the Drawings

Figure 1 is a sectional perspective view of the layered upper material prior to heat embossing.

Figure 2 is a sectional perspective view of the layered upper material after heat embossing.

Figure 3 is a plan view of a first embodiment of an embossed pattern for an upper.

Figure 4 is a plan view of a second embodiment of an embossed pattern for an upper showing one side of the upper.

Figure 5 is a plan view of a third embodiment of an embossed pattern for an upper.

Figure 6 is a plan view of a fourth embodiment of an embossed pattern for an upper.

Figure 7 is a plan view of a fifth embodiment of an embossed pattern for an upper.

Figure 8 is a perspective drawing of a shoe made from the first embodiment of the upper.

Figure 9 is a schematic drawing of placement of uppers in a multiple-upper cutting pattern.

Figure 10 is an elevational view of an embossing mold as used in the process of the invention.

Figure 11 is a partial sectional side view of the upper material on the bottom mold plate prior to embossing.

Figure 12 is a partial sectional side view of the upper material on the bottom mold plate after embossing.

Figure 13 is a perspective view of a mold used according to the process of the invention.

Figure 14 is a side view of a shoe having a quarter overlay secured by a thermoplastic rivet.

Figure 15 is a side view of the thermoplastic rivet of Figure 14.

Figure 16 is a plan view of a one-piece upper used in the shoe of Figure 14.

Figure 17 is a side view of a shoe having a quarter overlay, a forefoot stabilizer, and a tougue secured by thermoplastic rivets.

Figure 18A is a plan view of the one-piece upper used in the shoe of Figure 17.

Figure 18B is a cross section of Figure 18A.

Figure 19A is a plan view of two quarter overlays of a thermal plastic urethane material.

Figure 19B is a cross section of Figure 19A.

Figure 20A is a plan view of a forefoot stabilizer of a thermal plastic urethane material.

Figure 20B is a cross section of Figure 20A.

Figure 21A is a plan view of two quarter overlays of a heat embossed foam/fabric material.

Figure 21B is a cross section of Figure 21A.

Figure 22A is a plan view of a forefoot stabilizer of a heat embossed foam/fabric material.

Figure 22B is a cross section of Figure 22A.

Figure 23A is a perspective view of a thermoplastic fastener.

Figure 23B is a side view of an unfolded thermoplastic fastener.

Figure 23C is a rear view of a shoe upper partially fastened at the heel by a thermoplastic fastener.

Figure 24 is a side view of a casual shoe embodying the present invention.

Figure 25 is a plan view of a main upper portion used to form the shoe of Figure 24.

Figure 26 is a plan view of a quarter overlay in the shoe of Figure 24.

Figure 27 is a cross sectional view of the overlay of Figure 26 taken along line 27-27.

Figure 28 is an alternative quarter overlay.

Figure 29 is a side view of a shoe using the upper of Figure 28.

Detailed Description of the Preferred Embodiments

The present invention comprises a method for making shoes and shoe components and the shoes and shoe components made by this process.

Most types of shoes may be made with the method of the invention. Thus, flat heeled shoes, high-heeled shoes, and shoes with buckles, straps connected to both sides of the shoe and extending across the top of the foot, lacing, velcro attachment straps or other fasteners may be made with the process of the invention. Additional decorations or cut outs may also be added to the basic show pattern.

As shown in Figures 1 and 2, the upper 10 is preferably comprised of a plurality of layers and most preferably of three layers. Additional layers may be added for durability or strength. A process known as a combining process which is well known in the footwear manufacturing field, may be used to make a layer of fabric adhere to each side of a foam core 12 layer. In the preferred embodiment, the layers are held together by neoprene cement. The bottom sheet (lining) is placed in a mold and coated with cement and then the foam layer is placed on the lining. Finally, another layer of cement is applied and the fluid layer is added. The mold is

then closed to press the layers together. Other methods of layer formation may be used.

In a preferred embodiment, the layers are held together by adhesive systems of a thermo-set (cross-linked) nature. However, adhesives in the thermoplastic family may also be used providing they exhibit melting properties in excess of the process temperatures associated with the other components of the material. Alternatively, flame lamination techniques can be used which eliminate the need for adhesives altogether.

A preferred core material 12 is a foam product of the polyurethane family of an ether origin (i.e. polypropylene glycol), which is treated with a diisocyanate in the presence of water and catalyst agents. Density of preferred foams run 1.5 - 4.0 lbs/ft but foams of higher and lower density have application in some end use catagories. Many foam core materials originate from variations inside of the polyurethane family. Others utilizing polymer backbones which fall outside the polyurethane group can also be used as core materials.

In one preferred embodiment, the outer layer is a warp knit fabric classified as "tricot." The term refers to a fairly wide range of finished goods, some of which are acceptable in a shoe molding process, and some which are not. In particular, two bar knits such as full tricots and warp lockknit have shown particularly good characteristics with regard to the molding process as well as end use.

In another preferred embodiment, the outer layer is a weft knit fabric of jersey, rib, or purl designation. Variations of the jersey designation show particularly good properties due to their dimensional equality in elasticity. Many other variations of weft knitted fabric have also shown good success in the process and end use.

In still another preferred embodiment, the outer layer is of the woven classification. In utilizing woven structure fabrics in the fabrication process, success is more dependent upon yarn schemes than in knit fabrics. While a characteristic of knitted structures is fabric stretch or elasticity, wovens possess lower stretch values due to the somewhat linear relationship between fabric and yarn width/length. Therefore, in utilizing woven materials in the process, it is necessary to focus on yarn elasticity properties. Methods of incorporating elasticity in yarns are well known and may include texturing or using bi-component or bi-constituent yarn or fiber.

A different preferred embodiment uses an outer layer made of a product of the leather designation. Such leathers may be derived from cow, steer, bull, water buffalo, pig, calf, etc. Hides can be tanned by methods which produce leather products compatible to the shoe fabrication method of the present invention. Considering the durability of general leather products, a property necessary to use leather successfully is multi-directional extension with a low corresponding loss of basic strength properties such as tear. In one application, this is accomplished by splitting the leather hide down to relatively low gauge (0.4 - 0.6 mm.) and laminating the resulting veneer to a substrate of substantial properties. Substrate nomination is contingent upon final component requirements.

In another preferred embodiment, the outer layer is of synthetic polymer products such as polyurethane, P.V.C., or synthetic rubbers, in either cellular or solid state. Industrial processes may be used to to fabricate products that use synthetic skins or coatings on a fabric substrate. Two such methods used extensively in the industry are "wet" and "dry" processing. Because of their low cost, such

materials can be engineered in a multitude of methods to produce a wide range of physical properties and appearances.

Considerations governing choice of inner and outer layer materials include embossability of the outer layer, which includes scorch resistance to heat but also requires ability to take the embossing and retain the form in conjunction with the foam layer; sufficient tear strength of one or both layer; comfort of the inner layer; durability of both layers; appearance of the outer layer; and flexibility of both layers.

The uppers 10 are cut from the embossed, layered material using a variety of methods. These include, but are not limited to, standard knife edge die, knife edge gang die, dual function mold/die method, automated vertical die cutting, automated roller die cutting, automated laser method, and template/guide automated cutting. The die or template may be designed to cut one or more uppers at a time.

One example is the spacing of four upper patterns 18 as shown in Figure 9 on a single cutting die or template guide will allow interlocking of the patterns on the upper material and will minimize material waste. Generally, a square sheet of material about the size of the mold is used. After embossing, the embossed sheet is demolded and the molded upper is then cut out of the square sheet. A gang cutting die with a template guide is generally used for a multi-cavity mold.

The shape of the upper 10 is constrained by the shape and size of the foot but may be designed for a wide variety of shoe styles. As shown in Figure 3, beginning on one side of the shoe, the one-piece shoe upper 10 extends in a "U" or "V" shape from a first central back side 20 of the upper to a first shoe side 22 to the first side front 24, to the toe

area 26; and then the second side extends in mirror image to the first side from the toe area 26 to the second side front 28, the second shoe side 30 and the second back side 32 of the upper 10. The dotted line in Figures 4-7 show the central point on each side of which the shape of the shoe is a rough mirror image of the other side, the difference between sides being that the shoe side 22 or 40 which is on the inside of the foot may be cut with a small indentation or other variation to assist in lasting the side of the shoe that will be on the inside of the foot. A strap 34 may extend over the top of the foot connecting the sides 22,30 or the side fronts 24, 28 (Figures 3 and 4); or each side may have a laceable strap 36 (Figures 5 and 6) or a strap from the other side. The upper 10 over the top of the foot may be solid without a cut away area 38 or there may be no strap(s) at all (Figure 7).

Before the layered material is cut (trimmed), it is placed in a heat molding press to emboss a design 40 on the material and to flatten the edges 42. The embossing process heat-fuses the edge seams including the upper edges 48 thus making the multi-layered material totally enclosed without stitching the edge seams and thus enables the labor-saving use of the one-piece upper.

Embossing 40 in the toe area 26 and side fronts 24,28 (Figure 3) helps maintain the toe box shape and embossing lines 40 on the strap 34 help curve the strap across the instep. Additional embossing adds to the rigidity of the shoe upper so that it better retains a desired shape. All of the embossing may be shaped for aesthetic styling. Edge 42 is the lasting margin that is lasted under during the lasting process. A logo may be placed on the shoe in a logo area 41 embossed on the shoe. The design may be formed on any portion of the shoe. In Figures 3-7, a variety of side

designs are shown. The design may extend across the strap 34 as shown in Figures 3-4. It is important to note that the heat fusing and embossing of a design on natural materials such as cotton or leather as well as on nylons, polyesters, and other synthetic materials to form a three-layered laminate shoe upper is a unique and important aspect of this invention.

Embossing additionally serves to manage strain in end use. Since embossing lines are used extensively to create designs and patterns, it is possible to use these points, or add additional points which become part of the design pattern. This embossing then serves to control upper component strain by "locking off" outer shell or substrate fiber length. This technology serves to provide the shoe designer with unlimited control over shoe upper end use dynamic properties, by allowing extensive adjustment of specific modulus properties in locations of stress and associated strain. For example, it is well known that basketball shoe top collars which are properly functional stretch to a degree to allow the wearer a snug fit around the lower portion of the leg when fully laced. However, the shoe portions known as the in/out quarters, when properly engineered, require stretch properties which are considerably less than those of the top collar. By using the described method, a shoe designer may make function an inherent part of the shoe design. The method allows function to be incorporated into the shoe in the fabrication step itself.

A typical embossing mold 100 which is used in the process of the invention is comprised of hydraulic cylinders 102 and 104 that drive a top press plate 106 against a bottom press plate 108, while mold 110 is located in between (Figure 10). Both of the press plates 106,108 contain

heating elements 112 and 114. The heating elements 112,114 heat the press plates 106,108 which in turn heat the top mold plate 116 and the bottom mold plate 118 to the desired temperature. It is important to note that it is possible to use different temperature settings between the top press plate 106 and the bottom press plate 112 during the molding operation. This allows the top mold plate 116 to be either a higher or lower temperature than bottom mold plate 118 of mold 110 during the same molding process, thus allowing a more heat sensitive material such as thermoplastic urethane or PVC to be used on one of the surfaces.

For example, Figures 11 and 12 show partial cross sections of mold 110 and an upper prior to and during the embossing process. The use of mold alignment pins 120 on one of the mold plates as shown in perspective view in Figure 13 and mold pin alignment holes 122 enables proper alignment of the mold plates 116, 118. If outer layer 14 happens to be a heat sensitive material such as PVC, mold press plate 106 may be set at a lower temperature so as not to heat top mold plate 116 above the softening point of layer 14. The temperature of bottom mold plate 118 may or may not need to be increased to compensate for the lower temperature of top plate 116 in order to achieve the proper heat fusing of layers 14 and 16 to foam core 12. After the desired heating time, the top press plate 106 is raised and the embossing mold 110 is removed. The embossed, molded upper is removed and is ready for trimming of the excess material. In a preferred method of the invention with polyurethane foam, a three minute heating cycle at 200 degrees C is used. This temperature, in the presence of molding pressure, is adequate to accomplish internal cell wall bonding. Such bonding is a consequence of the heat and pressure which renders the cell matrix viscous to a point of

internal tack. This internal tack accomplishes setting of the areas of embossing. Although the heating of the foam is likely to be to a temperature less than its melting temperature, the embossed regions are here referenced as melted regions. Leather products, fabrics of natural and synthetic fiber, and synthetic material of P.V.C or polyurethane in combination with the foam can withstand this heating treatment without distortion or degradation of original physical properties.

As an alternate method of embossing, ultra-sonic or high frequency welding techniques could be used for embossing materials such as certain plastics that are not porous or discontinuous and have the requisite characteristics to enable embossing upon exposure to the high frequencies. High frequency heat is produced by using a transformer to raise the main voltage, a rectifier to change alternating current to direct current, and an oscillator valve to stop and start the current at speeds of about 28 million cycles per second or greater, to establish a field between two metal plates.

High frequency heating differs from radiant and conducted heat in that the temperature is raised uniformly throughout a material without a necessary waiting period for heat to spread from an exterior heat source to the interior of the material. In using high frequency heating with the invention an oscillating electronic field is created between two surfaces between which is positioned the upper material. Exposure to this field results in movement of the molecules in the upper and uniform generation of frictional heat throughout the upper. The use of a high frequency heating field plus pressure from the protruding portions of a mold result in the embossed design on the upper. The mold may

also be used to cut the perimeter of the upper by having a raised edge around the outside edge of the mold.

High frequency welding with a welding die also may be used to fuse two pieces of material, such as the two back edges of the upper, or to add extra components to the upper (such as a tongue, trim, buckles, etc.). High frequency (HF) welding is particularly suited to such materials as PVC and would allow the fusing of color pigments or appliques to the embossed areas.

After the upper 10 is completely embossed, a back strip 44 is attached to the back sides 20, 32 of the upper 10 using stitching methods known in the art as shown in Figure 8. The back strip 44 may be a straight narrow strip of 3/8 to 1/2 inch width and approximately double the length of the backside so that it may be sewn to both the inside and outside of the back shoe seam forming a fold 46 at the top edge 48 of the shoe 50. Alternatively, the back strip 44 may only be placed on the exterior to the shoe 50. The back strip 44 may also be decoratively designed in color and/or shape. If the back strip 44 is omitted, an alternative method of attaching the back sides of the upper, such as overlapping the back sides and stitching, or heat embossing the two sides together may be used.

According to a method of the invention, the shoe 50 is lasted with any of several conventional techniques. Preferably, of these techniques, cold cement lasting is used because it is the simplest lasting method and is less costly than others, but California lasting (full sock lasting) may also be used. The insole board that is used is preferably made of non-woven, cellulose base fiber board prepared by conventional techniques, but it may be made of other hard or soft fiber lasting boards. The sock liner preferably is made of Tricot-covered rubber sponge, but it could be made

of any fabric-covered cushioning material. When the shoe is lasted, lines A and B are aligned in parallel in shoes with a strap 34 (Figure 3).

Following attachment of the back strip and lasting, the bottom 52 of the shoe is attached, preferably by a cementing method. Cold cementing is preferably used because it is inexpensive and simple. The bottom 52 is preferably made using molded ethyl vinyl acetate (EVA) by methods known in the art; however cut EVA may be used as may thermal plastic rubber. Other bottoming methods that do not entail the cement process may be used. These would require "direct-attached" polyurethane or thermal plastic rubber. Both of these latter techniques require California lasted shoes.

A preferred embodiment of the invention involves preparation of a three layered upper having an outer layer which is a warp knit, weft knit, woven fabric, leather product, or synthetic coated material. The central layer of the material is a polyurethane foam, and the inner liner may be any one of a number of materials. The laminate is heat embossed at 200 degrees C for approximately three minutes, after which the backsides of the the upper are attached together by means of stitching to a back strip. The upper is then lasted and attached to the bottom of the shoe by cold cementing or other conventional means.

A number of different components of a shoe may be made using heat embossing methods such as those previously described for the one piece upper. The heat embossing of shoe components is decorative as well as functional in several ways. For a multi-layered material having a layer of porous foam such as polyurethane foam, the heat and pressure of the heat embossing selectively causes the inner cell wall matrix to become viscous to a point that the

resulting tack is adequate to accomplish bonding. Thus, when heated, the polyurethane foam becomes a strong bonding adhesive which adheres firmly to surrounding material. For a material having the foam as a central layer between two outer fabric layers, the embossing serves to firmly seal the three layers together. The shoe components of the present invention are embossed along the edges and are thus sealed along the edges, removing the need for any edge stitching to hold the material layers together.

Another function of the heat embossing is to reduce the thickness of the material in the region of the embossing. Since shoe components are often joined at the edges, it is desireable to have the edges relatively thin compared to the rest of the material to prevent from forming an unusually thick region of the shoe where the connected shoe components overlap. Heat embossing along the edges of a shoe component provide this thinner region without the necessity of skiving, which is the traditional method of edge thickness reduction.

Shown in Figure 14 is a side view of a typical shoe 130 made with a heat embossing process. The shoe 130 has a heat embossed upper 132 and a quarter overlay 134 which is also heat embossed. The edges of the overlay 134 are embossed to reduce and seal them, while a more central region 135 of the overlay is embossed to hold eyelets 136, which in turn hold the laces of the shoe 130. The overlay 134 is stitched to the lasting margin of the upper and may be additionally secured by a thermoplastic rivet 138. During assembly, the two-piece rivet 138 is passed through aligned holes in both the overlay 134 and the upper 132.

A side view of thermoplastic rivet 138 passing through two pieces of material 139,141 shown in Figure 15. Front rivet plate 140 has two pins 142 which fit into the

receiving holes 146 of back plate 144. Heating of the thermoplastic rivet 138 causes the two pieces of the rivet to melt and bond together forming a secure permanent connection. This heating is preferably done with a high frequency electromagnetic field, which is particularly good for providing uniform heating of the thermoplastic material. Alternative heating methods such as ultrasonic heating or thermal welding may also be used. The pins 142 of the front plate 140 of the rivet 138 may extend through holes 146 and beyond the rear surface of back plate 144. In such a case, pressure applied to the back of the rivet 138 during heating then causes the end of the pins 142 to spread and flatten out along the rear surface of the back plate 144. Thus when the rivet hardens, the pins 142 are even further prevented from moving back through the holes in the back plate 144.

Using certain thermoplastic materials, the thermoplastic rivet 138 may alternatively consist of just the front plate 140. Once the pins 142 pass through the material to be joined, they are heated and the pins 142 are flattened out to restrict the rivet 138 from passing back through the material. Such a deformation of the rivet 138 may be accomplished through the use of a pressure device which applies pressure to the rivet 138 during heating.

Figure 16 shows a plan view of the upper of the shoe in Figure 14. Quarter region 148 is embossed flat to provide a seat for a quarter overlay 134. The lasting margin 150 is also embossed to seal the edge and to reduce the thickness of the lasting margin 150 without skiving. The upper is shown with one of two quarter overlays 134 in place. The other quarter overlay is left out to show the quarter region 148 of the upper, which is embossed flat to accomodate an overlay 134. Embossing this region 148 prevents the shoe from being abnormally wide in the overlapping quarter region

of the shoe. Rivet holes 149 are also shown in both the upper 132 and the quarter overlay 134.

In Figure 17 is shown a shoe 152 having an upper 153 and a number of overlay components. A heel stabilizer 154, a quarter overlay 156, and a forefoot stabilizer 158 are each attached to the shoe 152 during a bottoming process. A tongue 160 is also included, and both the tongue 160 and the forefoot stabilizer 158 are attached to the vamp 162 of the upper by way of a thermoplastic rivet 164. In this case the rivet 164 serves to secure both the tongue 160 and the forefoot stabilizer 158, thus providing an economical use of connection elements.

The overlay components 154,156,158 of the shoe 152 of Figure 17 are preferably made by an injection molding process using materials such as thermoplastic elastomers, or in some cases engineering thermoplastics. Some alternatives to the injection molding method include flow molding, casting, and extrusion process. The molded overlays are easy and inexpensive to produce and add support and aesthetic value to the shoe. Other materials such as the foam/fabric material of the upper or a natural material such as leather are also used as overlay material. A combination of different overlay components of different materials is often used on the same shoe.

Both the tongue 160 and the upper 153 of the shoe 152 are formed of a material with a central resilient foam layer. Heat embossing seals and reduces the material in selected areas. Figures 18A and 18B show a plan view and a cross sectional view, respectively, of the upper 153 of Figure 17. The lasting margin 156 of the upper 153 is embossed. Futher embossing of the upper 153 provides seats for the overlays shown in the assembled shoe of Figure 17. Since the non-shaded portions of Figure 18A are the regions

depressed by heat embossing, it is apparent that the embossed regions seat the heel stabilizer 154, the quarter overlay 156, and the forefoot stabilizer 156 perfectly. The cross section of Figure 18B shows the relative thickness difference between an embossed region 168 and a non-embossed region 170 of the upper 153.

Figure 19A is a plan view of the quarter overlays 156 and 156' of the shoe 152 of Figure 17 (overlay 156' is not shown in Figure 17). It can be seen from this view that the injection molded components are fabricated in a manner to reduce thickness gauge in the bottom region. These portions of the overlays are turned under during bottoming of the shoe, and it is therefore advantageous to have the thickness reduced in these regions 172. Figure 19B is a cross section of one of the quarter overlays 156, 156' and shows the difference in thickness in different regions of the TPU material. Much of the molded pattern is decorative, but it additionally serves to allow a certain degree of bending movement to the overlay. The mold also gives shape and texture to the surface of the overlay.

Shown in Figure 20A is a plan view of the forefoot stabilizer 158 of the shoe 152 of Figure 17. Like the quarter overlays 156, 156', this particular forefoot stabilizer 158 is made of a TPU material. The forefoot stabilizer is made flat in a central region 174 and at the ends 176 of the extending portions 177. Molded lines 178 in the remainder of the material provide texture and improve bending properties in this region. Holes 180 in the central region 174, support the pins 142 of thermoplastic rivet 138. The cross section of Figure 20B shows the difference in thickness between the different regions of the forefoot stabilizer.

Figure 21A is a plan view of an alternative embodiment of the quarter overlays 156 and 156' of Figures 17 and 19. Quarter overlays 180 and 180' still fit within the recessed regions of the shoe upper 153 of Figure 17, but are made of foam/fabric material instead of a TPU. The foam/fabric material is like that previously disclosed for the upper, and is embossed along the edges to seat the material. The quarter overlays 180 and 180' are also embossed at the bottom portions 182 and in the eyelet regions 184. The eyelets (not shown) are mounted in the regions 184, and the bottom portions 182 are attached to the lasting margin of the upper 153 prior to bottoming of the shoe. The raised non-embossed central regions 186 of the quarter overlays 180, 180' are instrumental in keeping the shape of the overlays. A cross section of one of the quarter overlays is shown in Figure 21B. From this cross section the thickness difference between the embossed and non-embossed regions of the foam/fabric material is apparent.

The forefoot stabilizer 188 of Figure 22A is similarly shaped to the forefoot stabilizer 158 of Figures 17 and 20, but is made of the foam/fabric material. The forefoot stabilizer 188 is embossed in the bottom regions 190, in the eyelet regions 192, in the rivet region 194, and along the edges. The embossing along the bottom region 190 allows proper attachment to the shoe upper. The embossing in the eyelet regions 192 provides a flat region for attachment of the eyelet (not shown). The embossing in the rivet region 194 provides a flat, recessed region in which the rivet 164 fits, passing through rivet holes 196. The raised, non-embossed region 198 gives shape and texture to the surface of the forefoot stabilizer 188. A cross section of the forefoot stabilizer is correspondingly shown in Figure 22B.

Figures 23A-23C shows a folding thermoplastic fastener 200 designed particularly for binding together the left and right heel portions of an upper. The fastener 200 is shown folded up in Figure 23A and partially unfolded in Figure 23B. Two rows of pins 202 on fastener rear plate 204 align with the two rows of holes 206 on fastener hole plate 208 when the fastener is folded over. As shown in Figure 23C, the reduced areas of the heel portions 210 of a shoe upper 212 are punched with holes 214 which align with the pins 202 of the fastener 200 when the heel portions 210 are pulled together. The pins 202 of the fastener 200 are then pushed through the holes 214 of the heel portions 210. The fastener is then closed along a hinge between the rear plate 204 and the hole plate 208, such that the holes 206 in the hole plate 208 engage the ends of the pins 202 sticking through the heel portions 210. Once engaged, the fastener is heated to melt the pin/hole connections such that when rehardened they are permanently secured. Decorative cover plate 216 is hinged to hole plate 208 and is folded over to cover the pin/hole connections. The cover plate 216 has a lip which meshes with a lip on the hole plate 208 to keep it tightly secured when folded over and pressed into engagement with the hole plate 208.

As noted above, the embossing allows for control of stress, contouring and flexibility of various portions of the shoe. Figure 24 illustrates a women's casual shoe which utilizes such functional embossing. The shoe upper is formed of a one-piece upper, illustrated in Figure 25, and quarter overlays, one of which is illustrated in Figure 26. As illustrated in Figure 25, the edge embossing 203 along the throat opening and the generally parallel embossing lines 205 and 207 in the vamp provide flexing in the forefoot. Because of the reduced thickness of the upper

material along these embossing lines, the upper is able to fold more readily along these lines. The embossing lines 209 and 211, which join the lines 203, 205 and 207, and the curved embossing line 213 help maintain the shape of the toe box. As viewed in Figure 25, those lines can be seen to surround a plateau region which spans the toe box. In the counter area at the rear of the shoe, horizontal embossing lines 215, 217 and 219 can be seen to allow a curve up along the heel with flexing along the horizontal embossing lines; yet the lines minimize front to rear stretching so that the heel does not stretch out with repeated use.

Just forward of the counter area in the rear quarter, vertical embossing lines allow the shoe to curve under the ankle. Thus, the flexing along these allows for contouring of the shoe. In the one-piece overlay of Figure 25, the quarter of the shoe under the quarter overlay is flattened completely. This flat section does not stretch but allows for substantial flexing in all directions. The quarter section does not encounter significant stress because it is the quarter overlays which are tied to absorb the stress across the shoe.

The overlay of Figure 26 is designed with two vertical embossing lines 226 and 228 which absorb the stress from the eyelets to the sole with minimal stretching. A cross-sectional view of Figure 27 illustrates the embossing lines 226 and 228 where any yarn in the fabric layers 230 and 232 is locked to the compressed foam layer 234 therebetween. The reduced thickness of the embossed lines 226 and 228 also allows bending along the embossing lines.

Figure 28 illustrates an alternative quarter overlay, and a shoe incorporating that overlay is illustrated in Figure 29. In this design, stretch from the eyelets to the sole is controlled by the horizontal embossing lines such as

236. Depending on the weave of the fabric layers, some stretching is allowed between the embossing lines. In this design, stretching from the eyelets to the shoe must be limited to a larger extent by the weave of the fabric than in the prior design, but the embossing lines allow for greater flexibility which allows the overlay to fold over the foot more readily.

The invention has great industrial applicability particularly in countries with a labor shortage or where it is essential to minimize labor costs to be competitive. The method of the invention may be used in the shoe manufacturing industry to make durable, attractive, inexpensive shoes through elimination or diminishing of most of the labor-intensive shoe fitting steps, such as skiving, multiple-piece stitching, prefitting, splitting, interlining, and edge taping.

While the invention has been described with reference to specific embodiments thereof, it will be appreciated that numerous variations, modifications, and embodiments are possible, and accordingly, all such variations, modifications, and embodiments are to be regarded as being within the the spirit and scope of the invention.

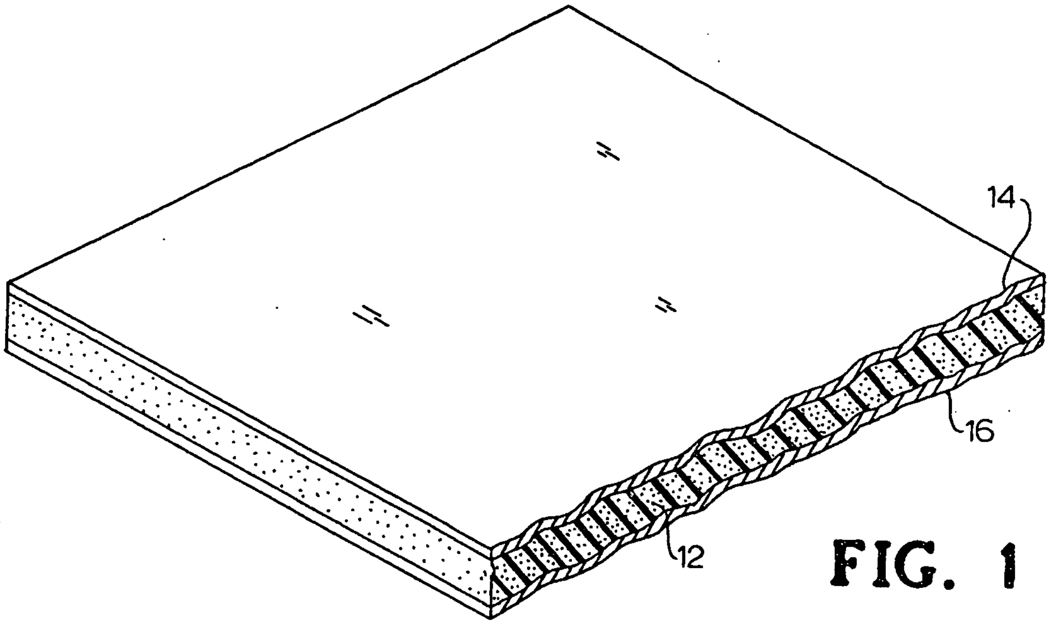

FIG. 1

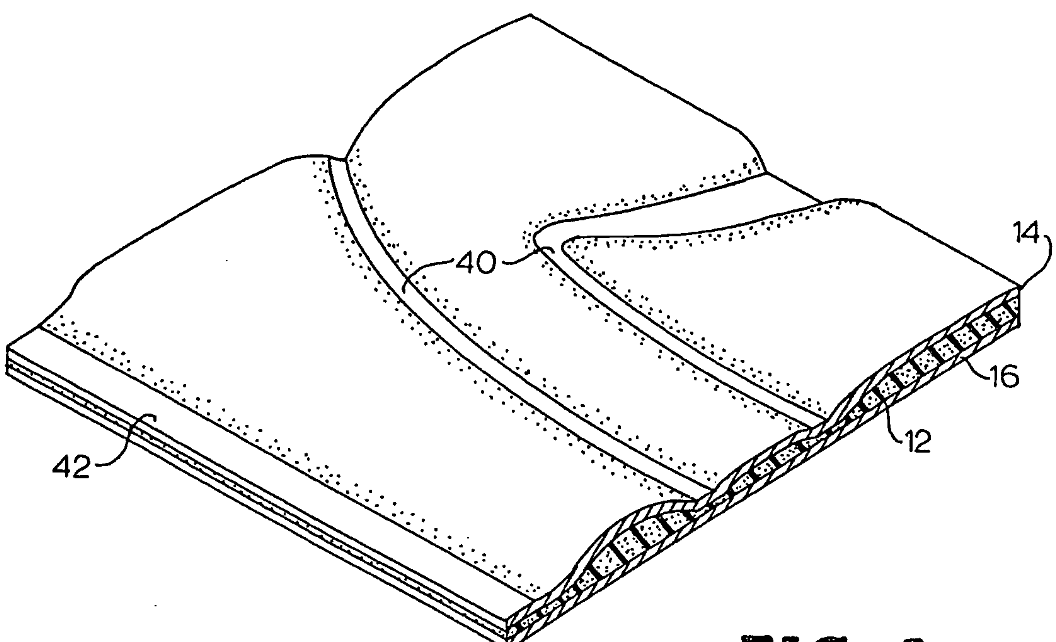

FIG. 2

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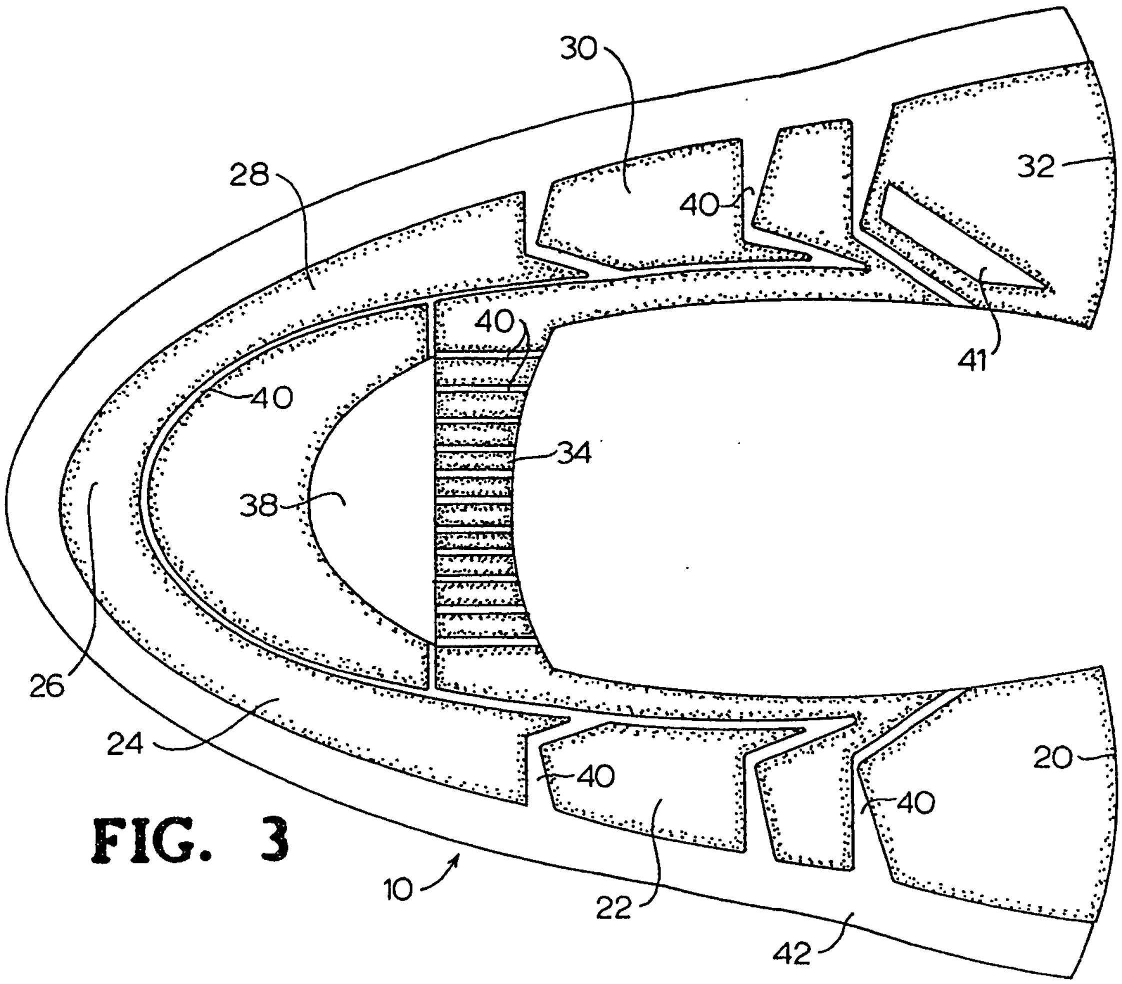

FIG. 3

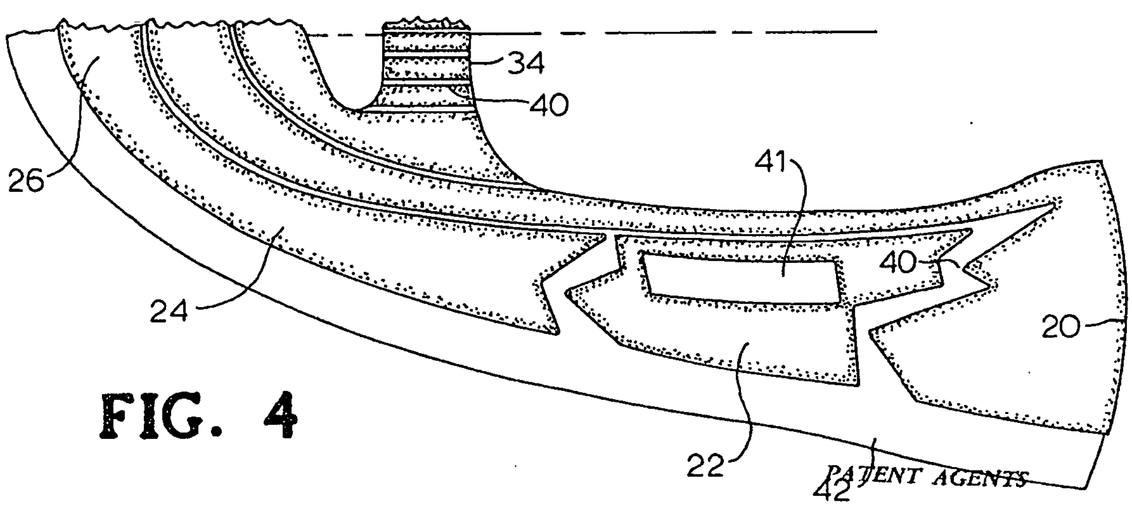

FIG. 4

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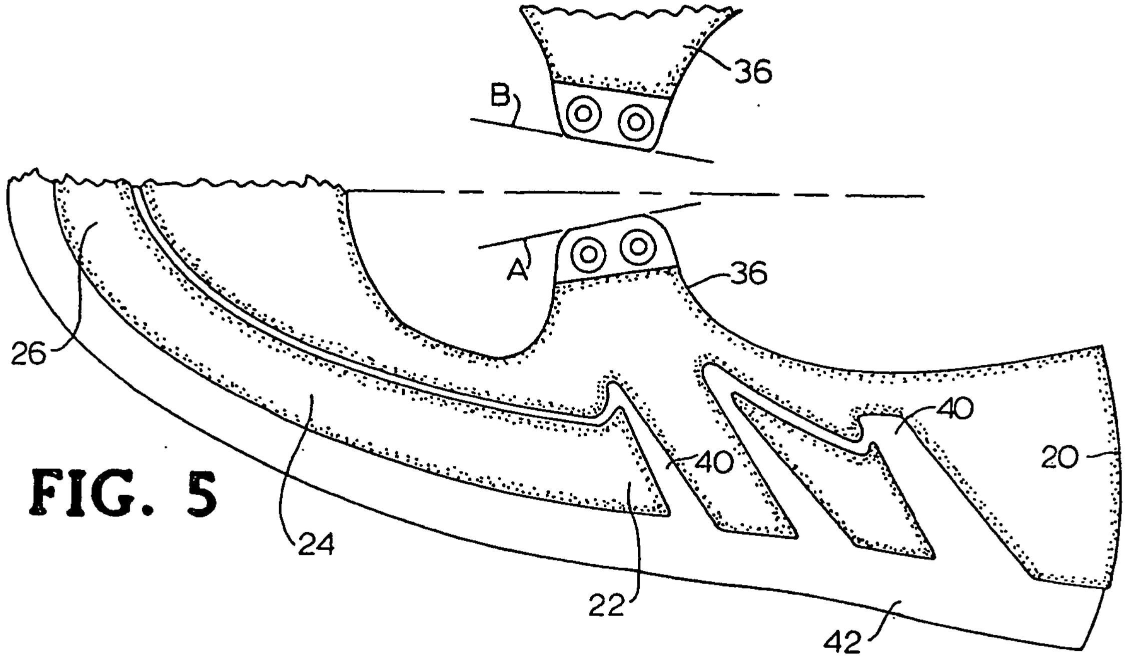

FIG. 5

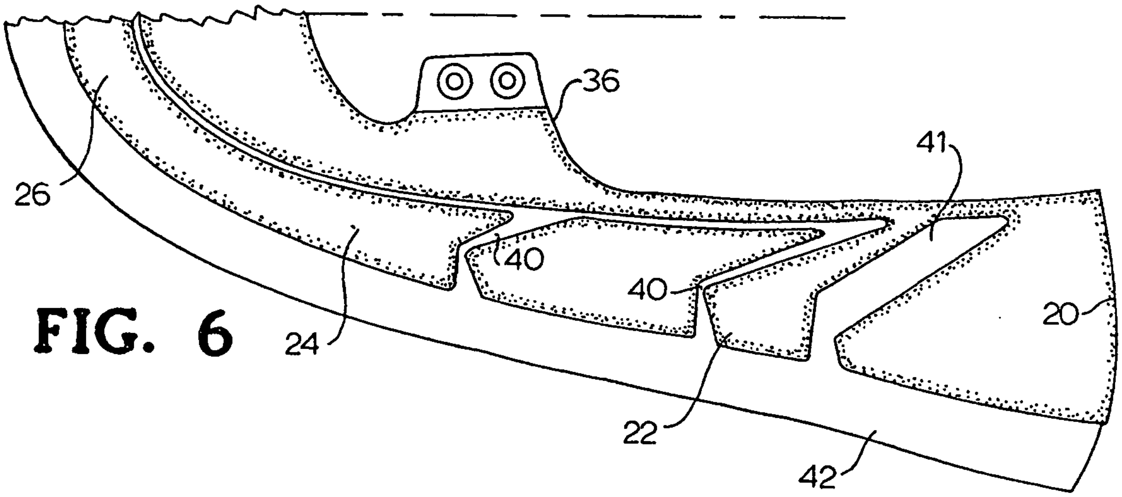

FIG. 6

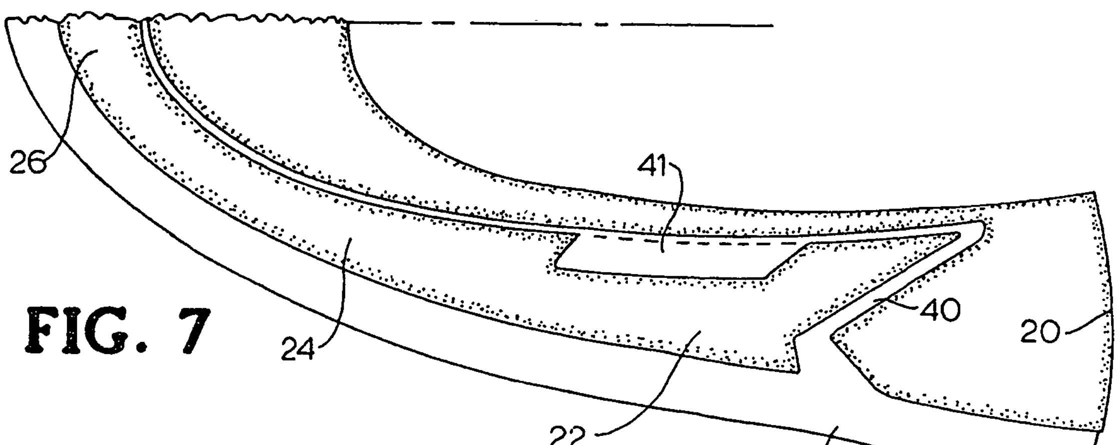

FIG. 7

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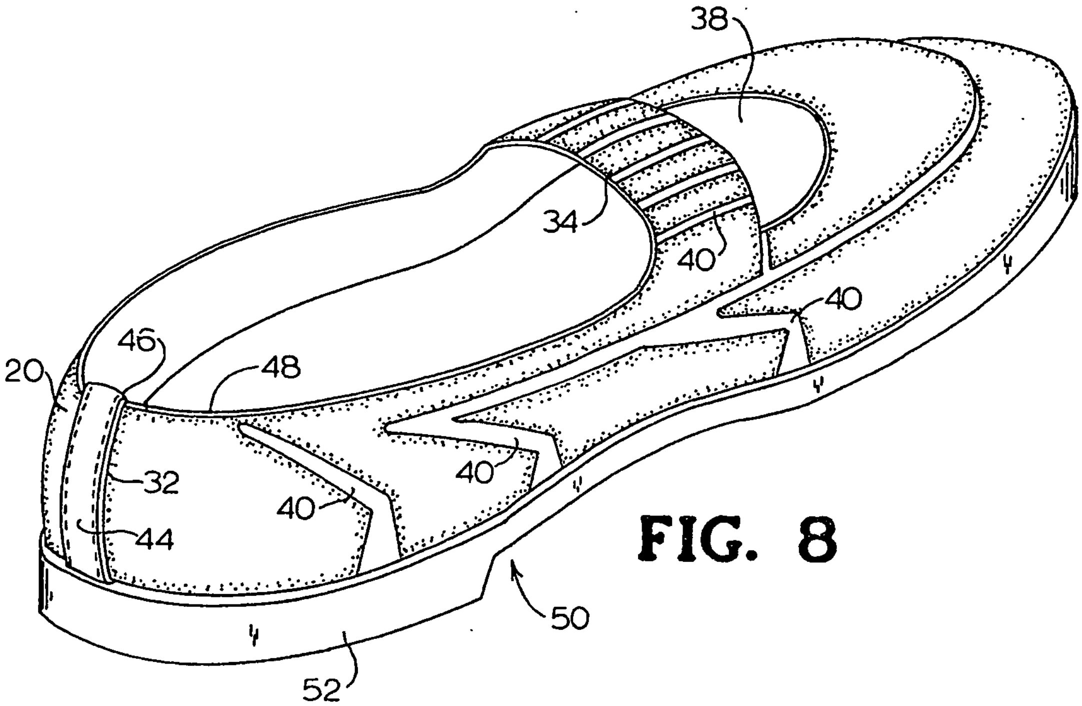

FIG. 8

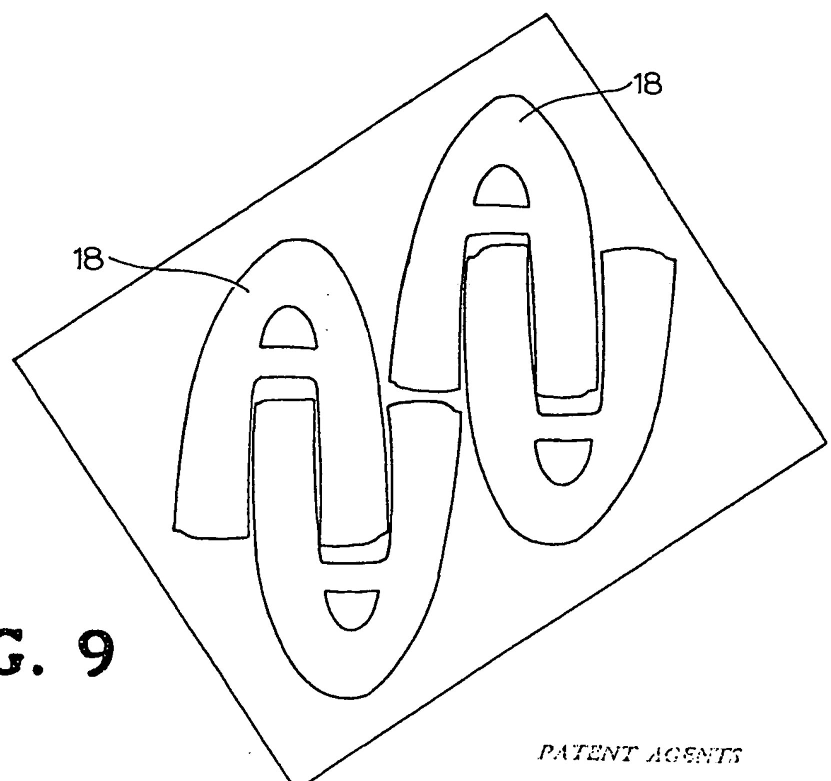

FIG. 9

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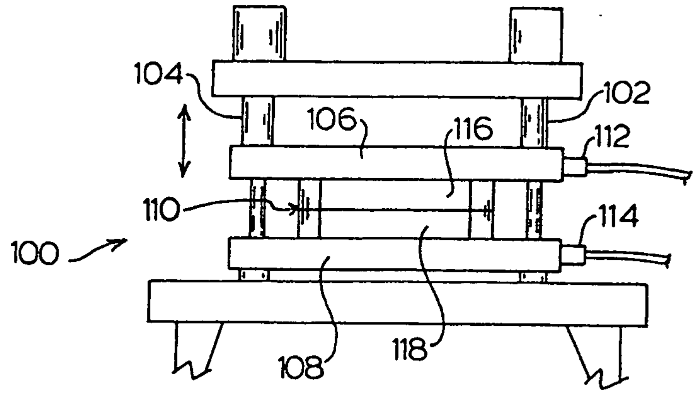

FIG. 10

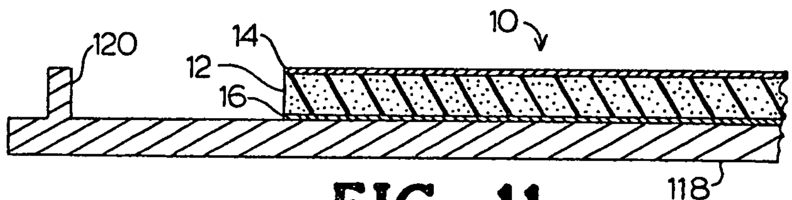

FIG. 11

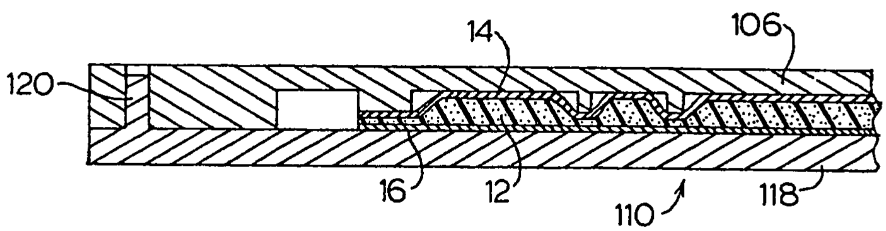

FIG. 12

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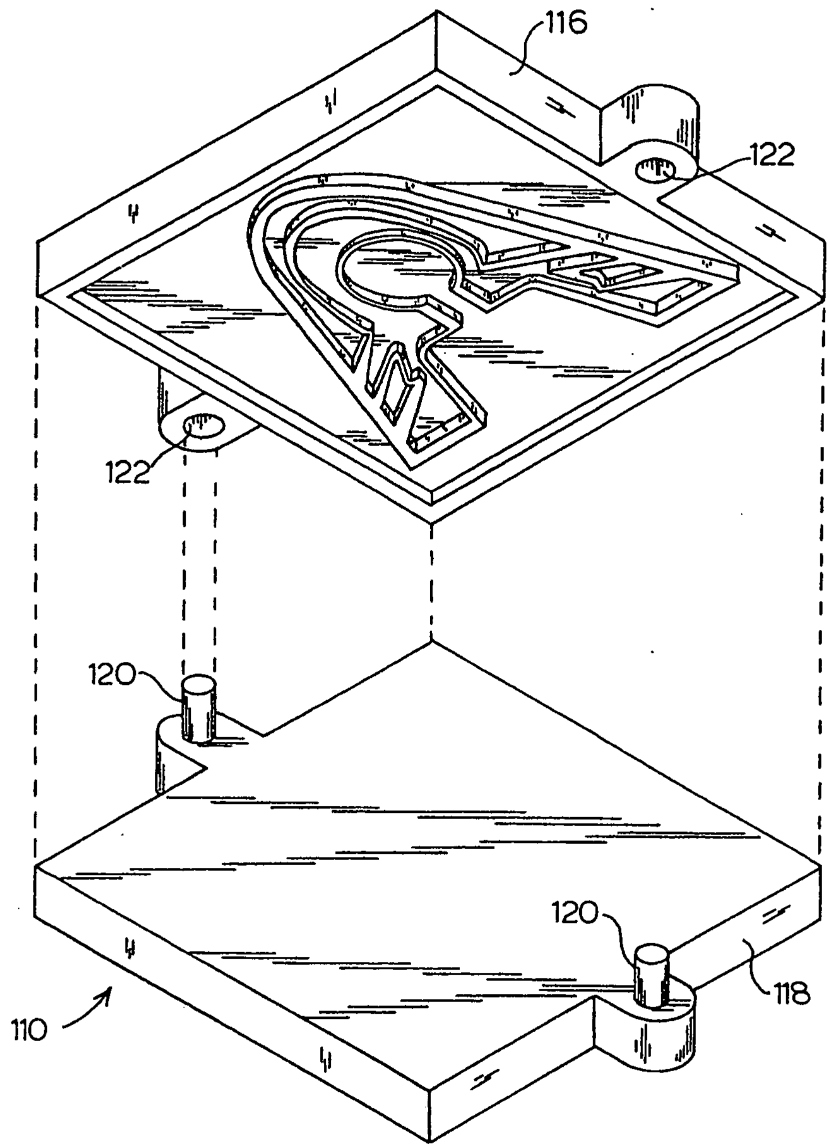

FIG. 13

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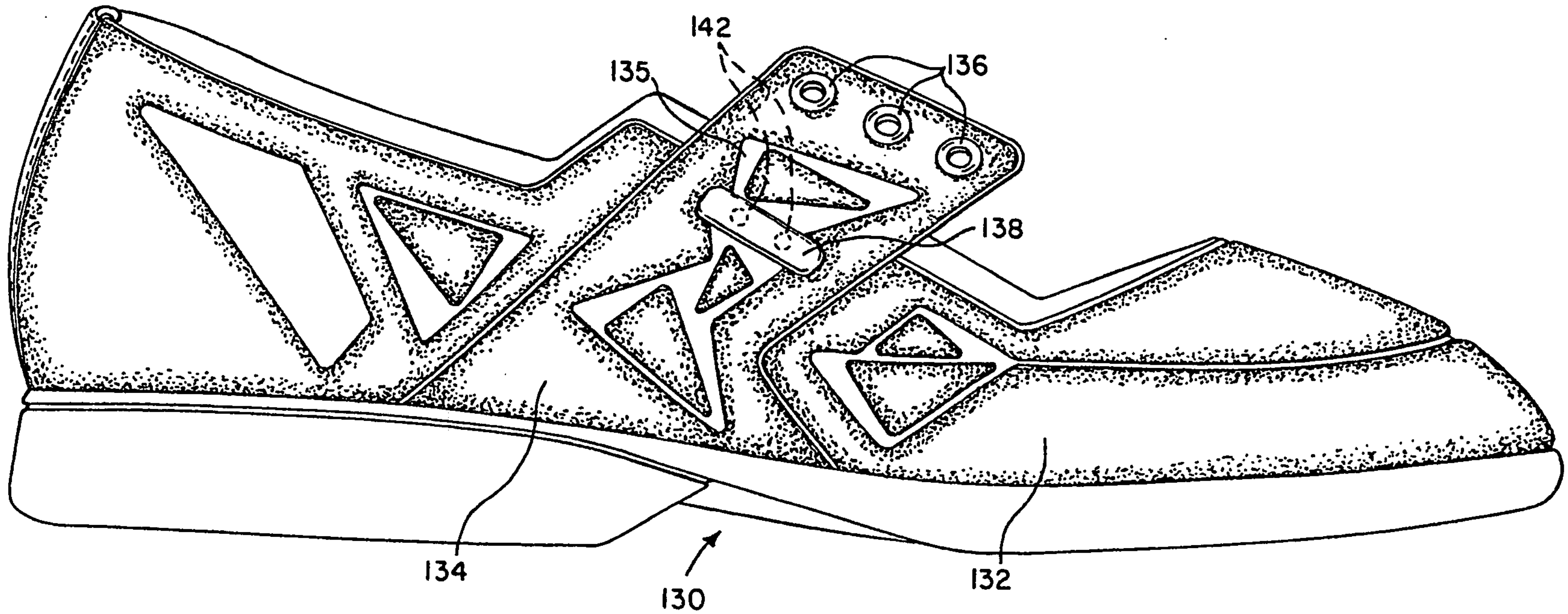

FIG. 14

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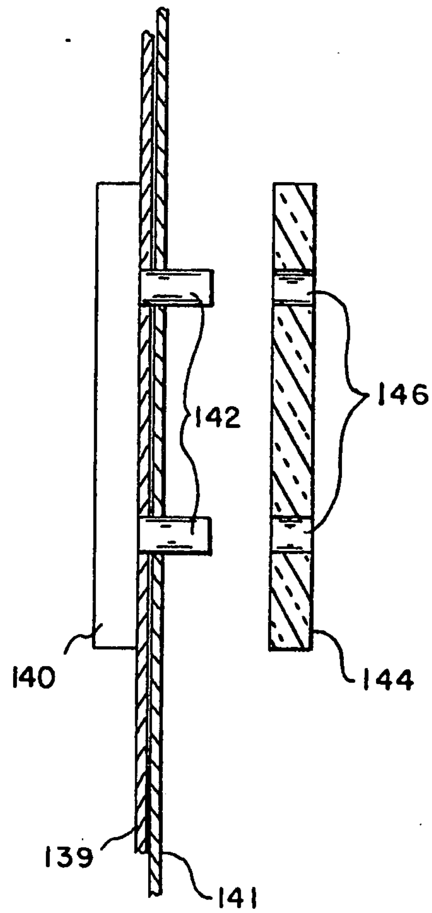

FIG. 15

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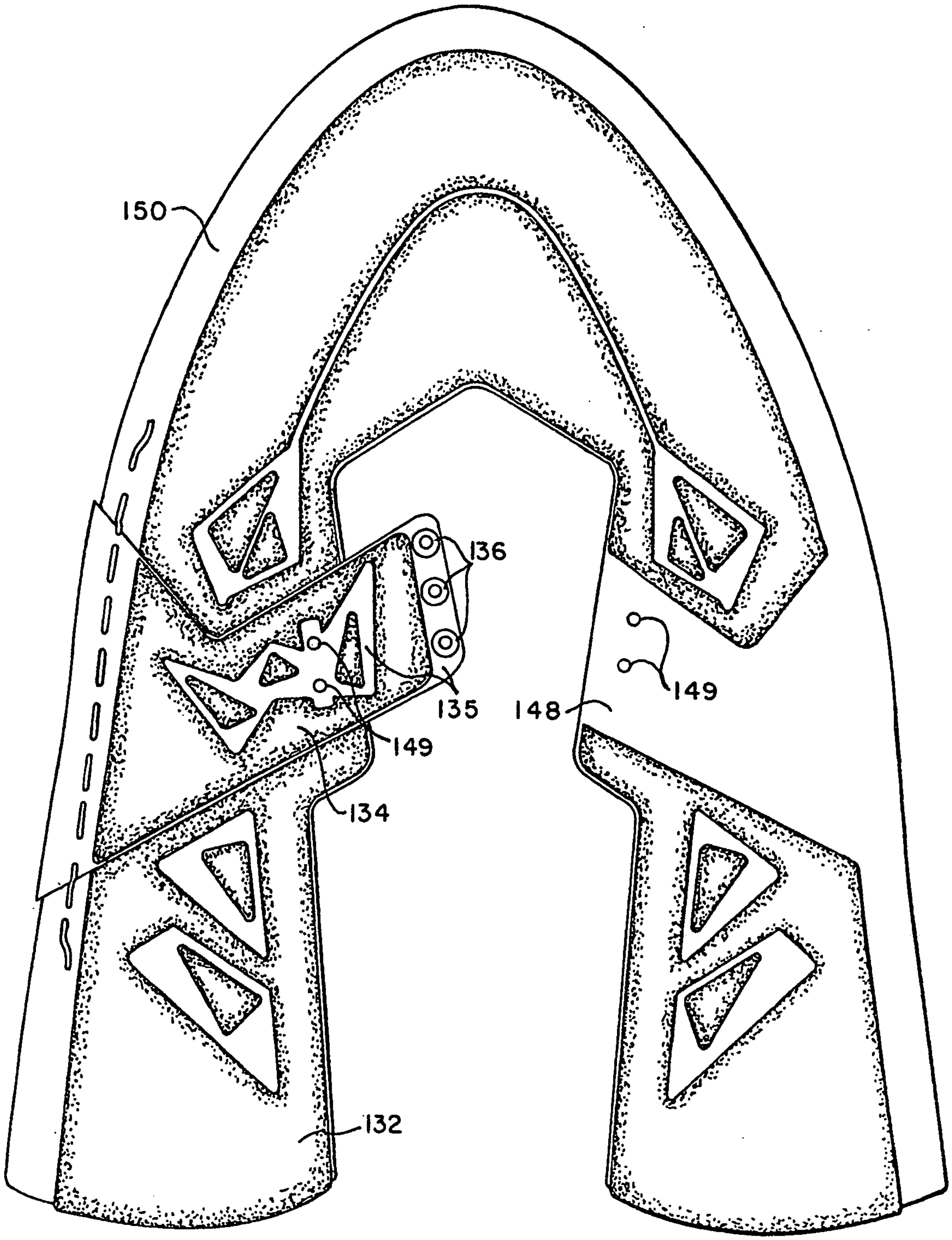

FIG.16

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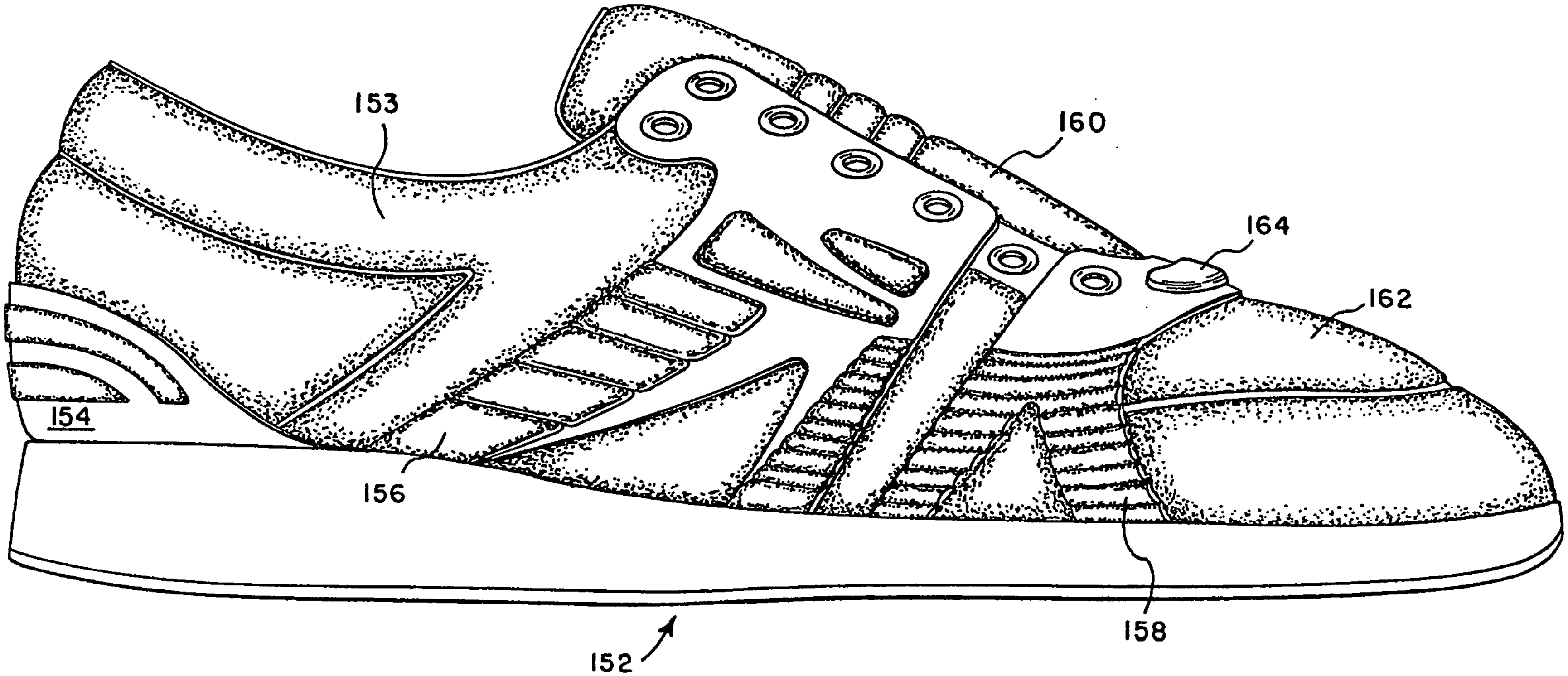

FIG. 17

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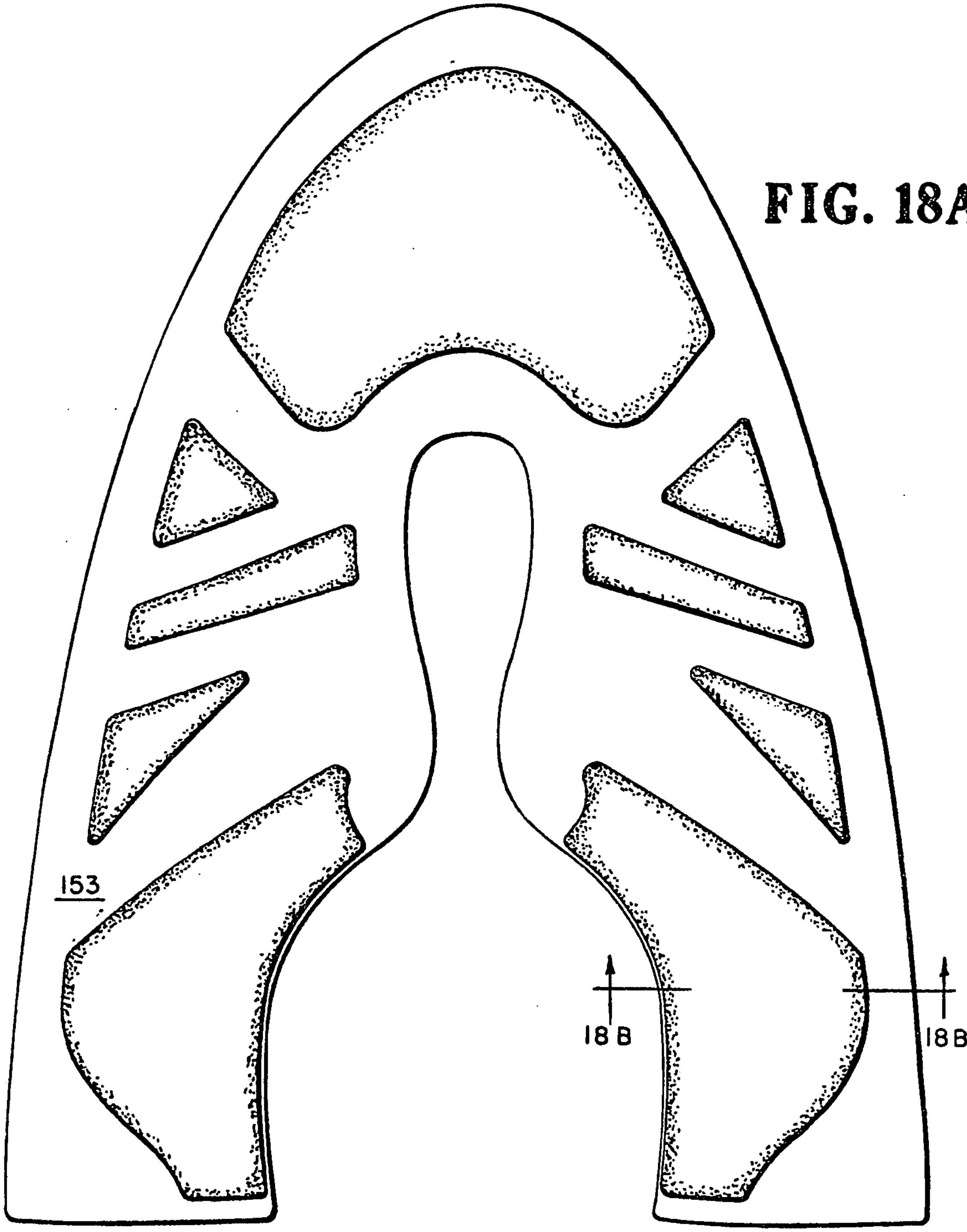

FIG. 18A

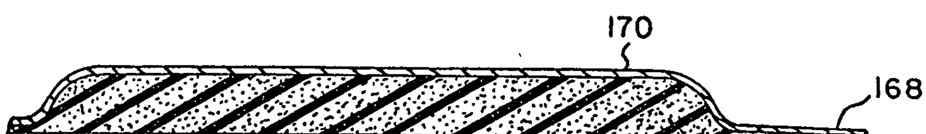

FIG.18B

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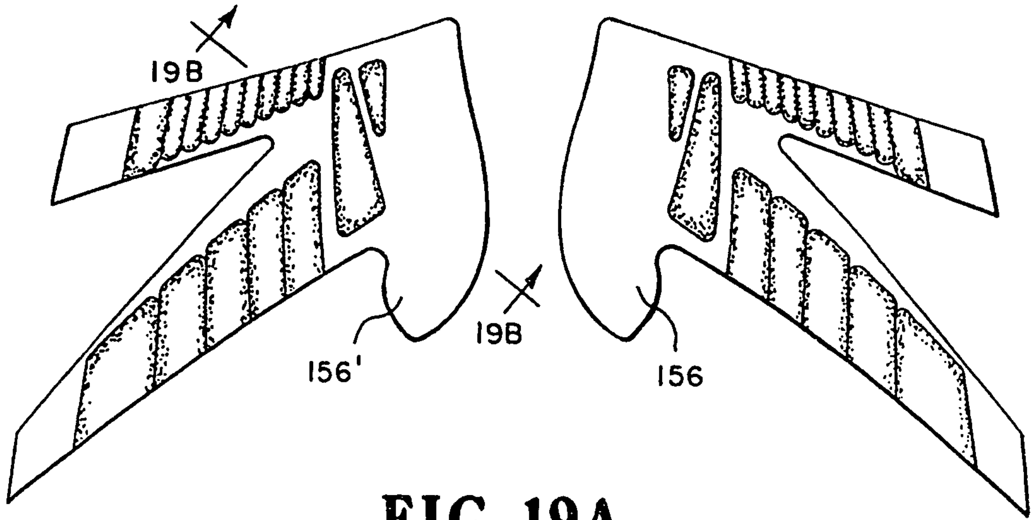

FIG. 19A

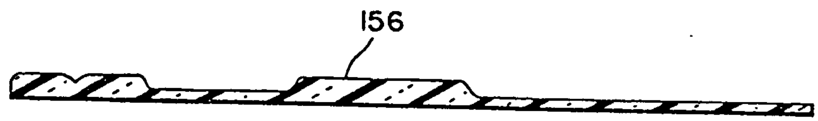

FIG. 19B

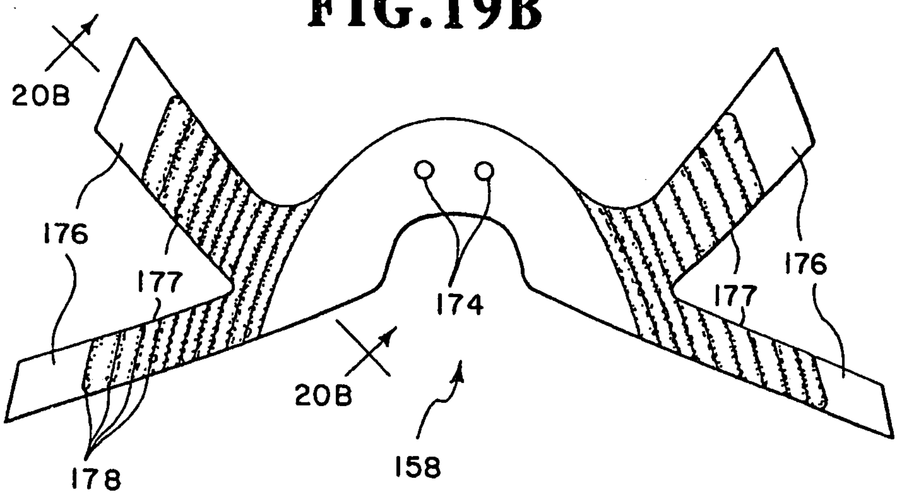

FIG. 20A

FIG. 20B

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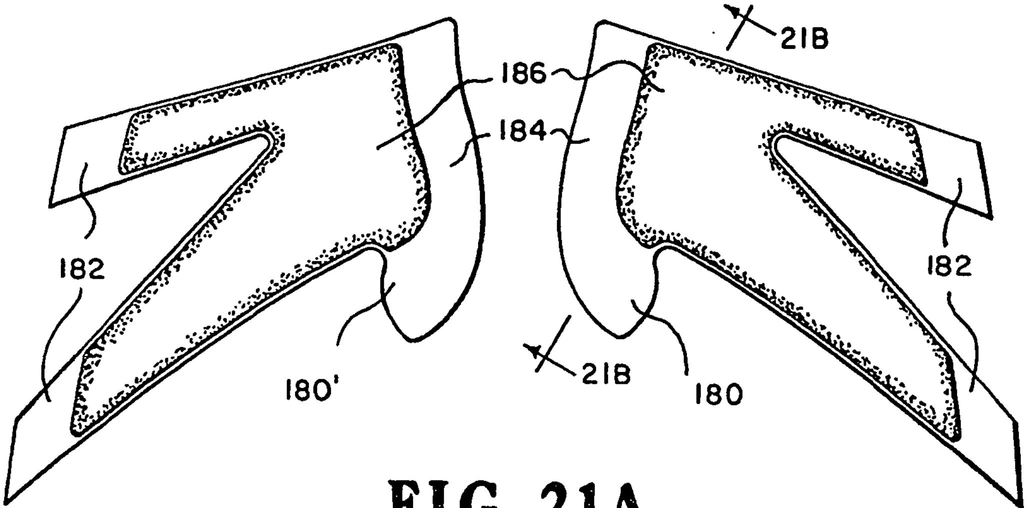

FIG. 21A

FIG. 21B

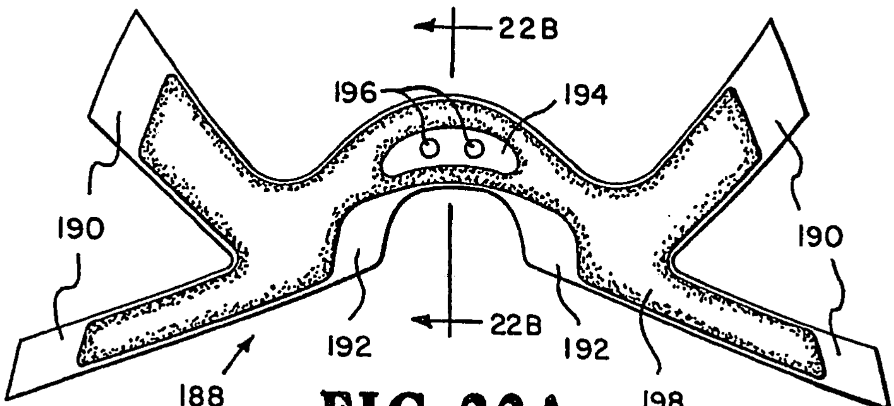

FIG. 22A

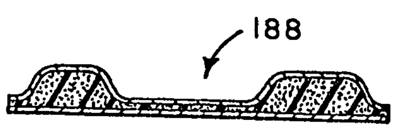

FIG. 22B

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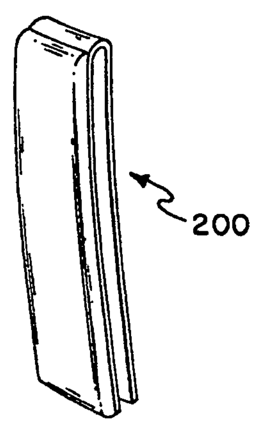

FIG. 23A

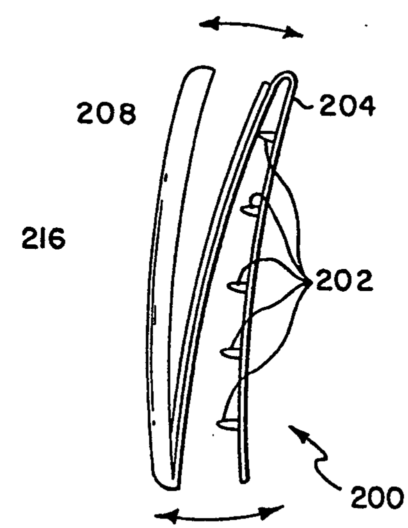

FIG. 23B

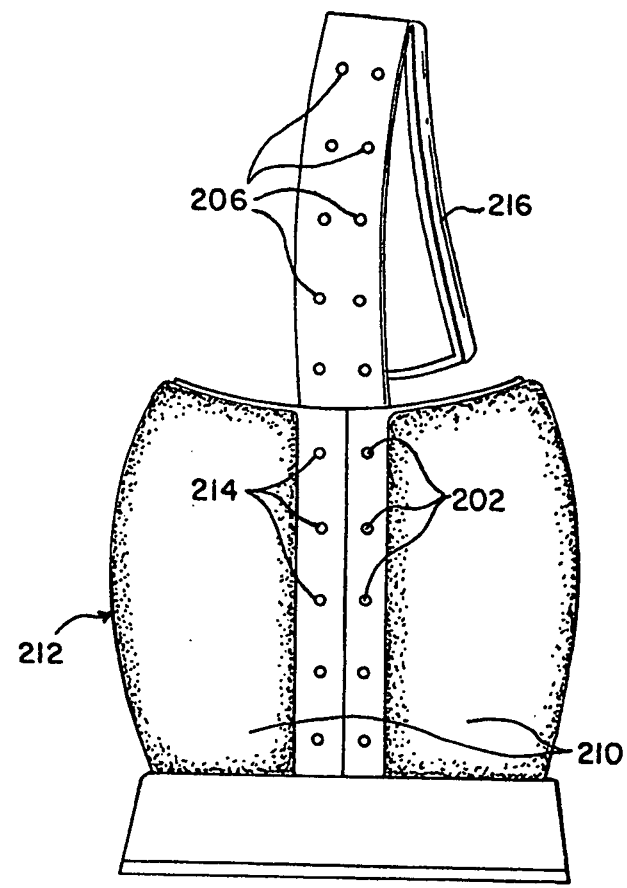

FIG. 23C

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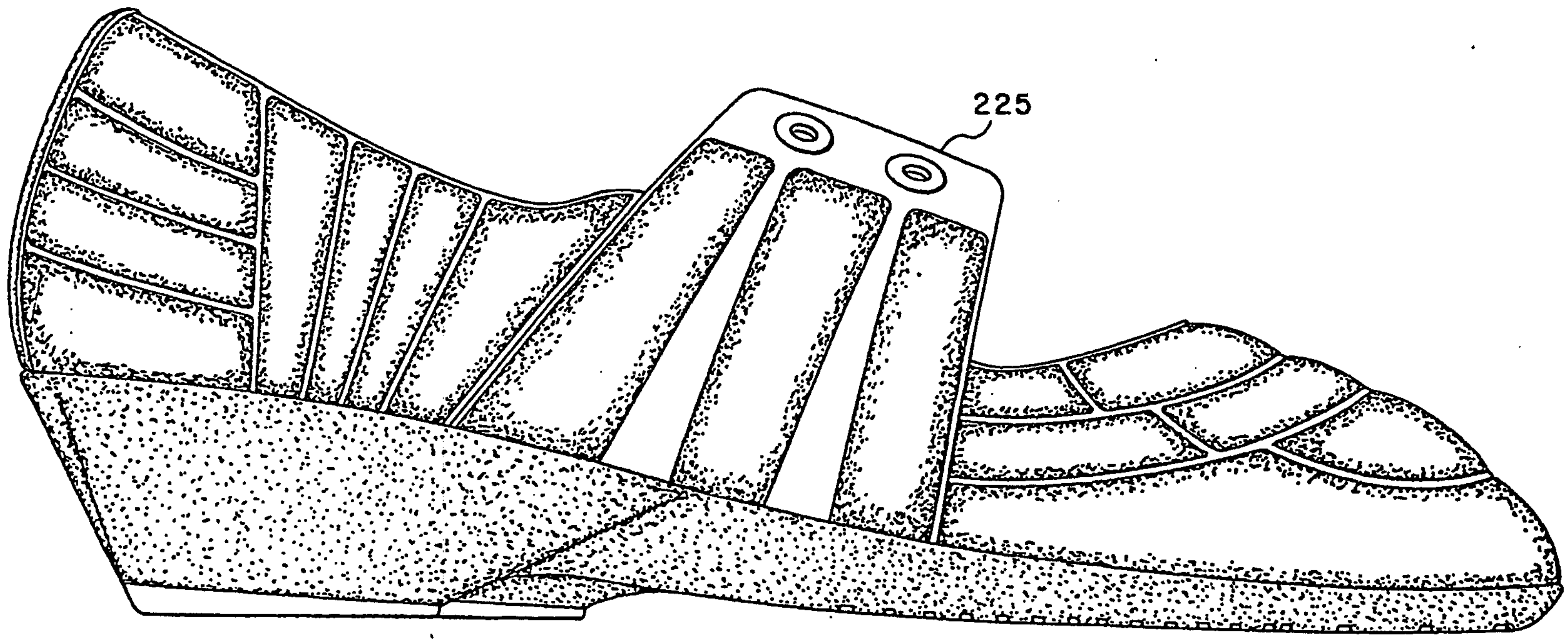

FIG. 24

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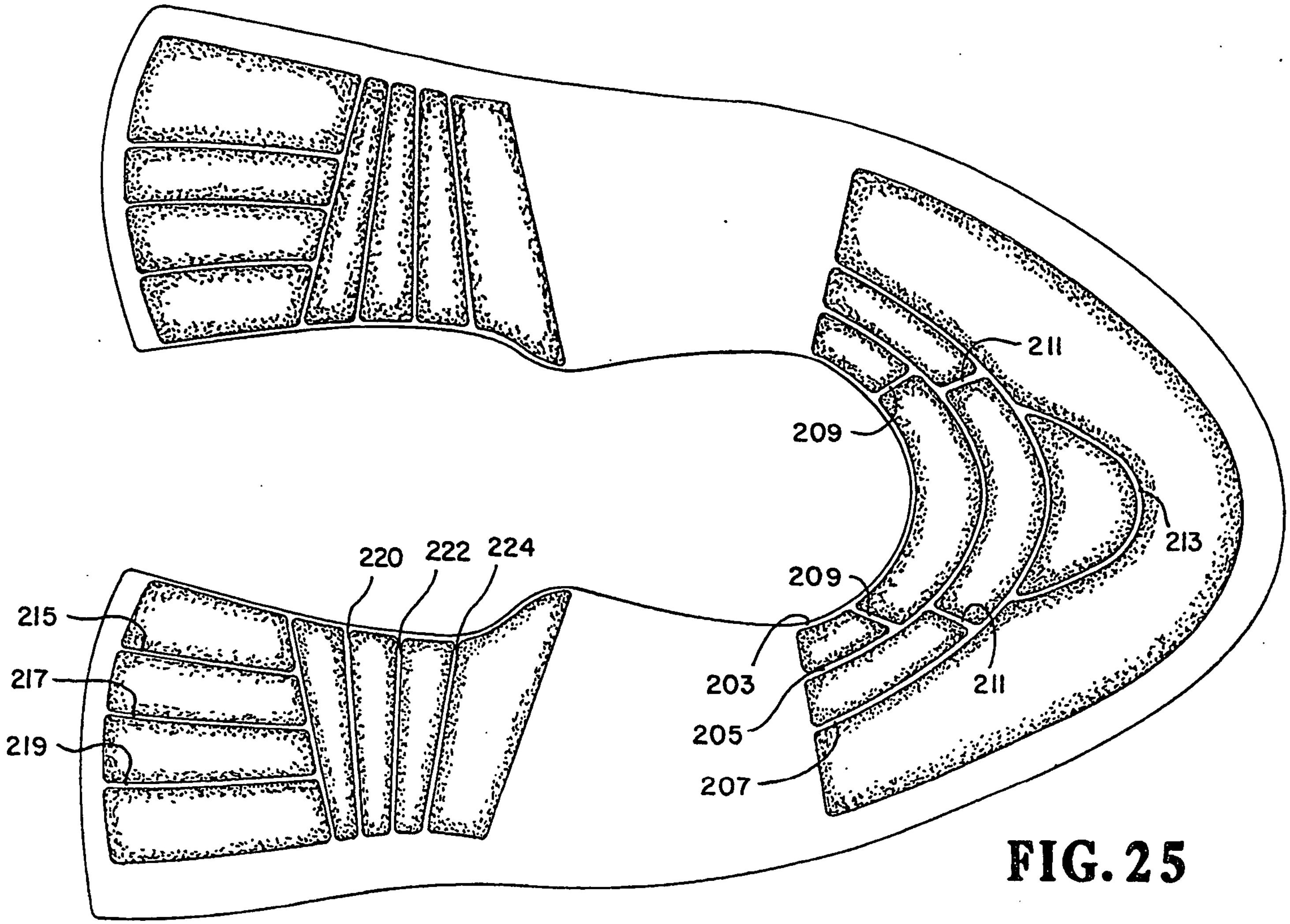

FIG. 25

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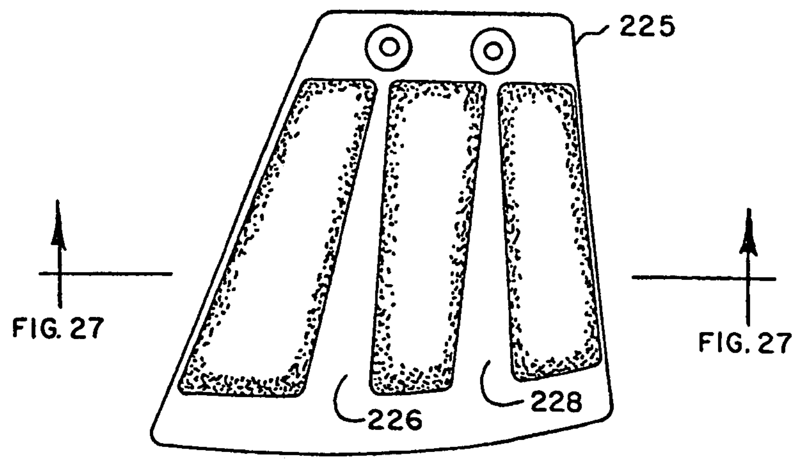

FIG. 26

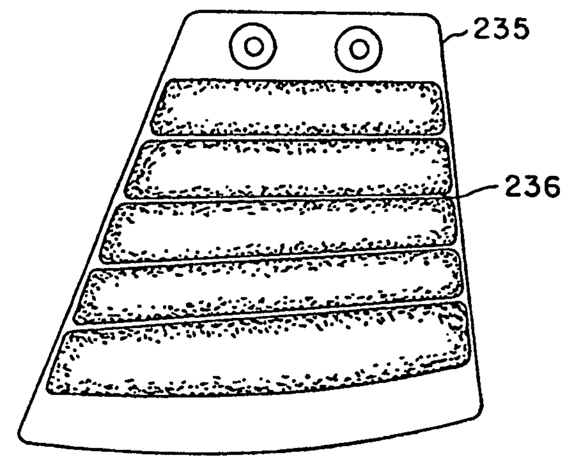

FIG. 28

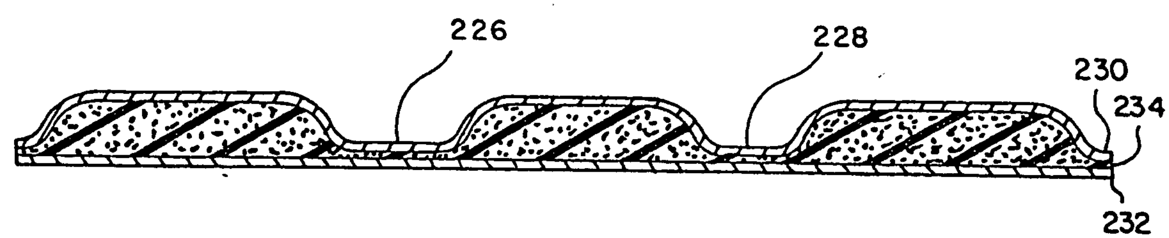

FIG. 27

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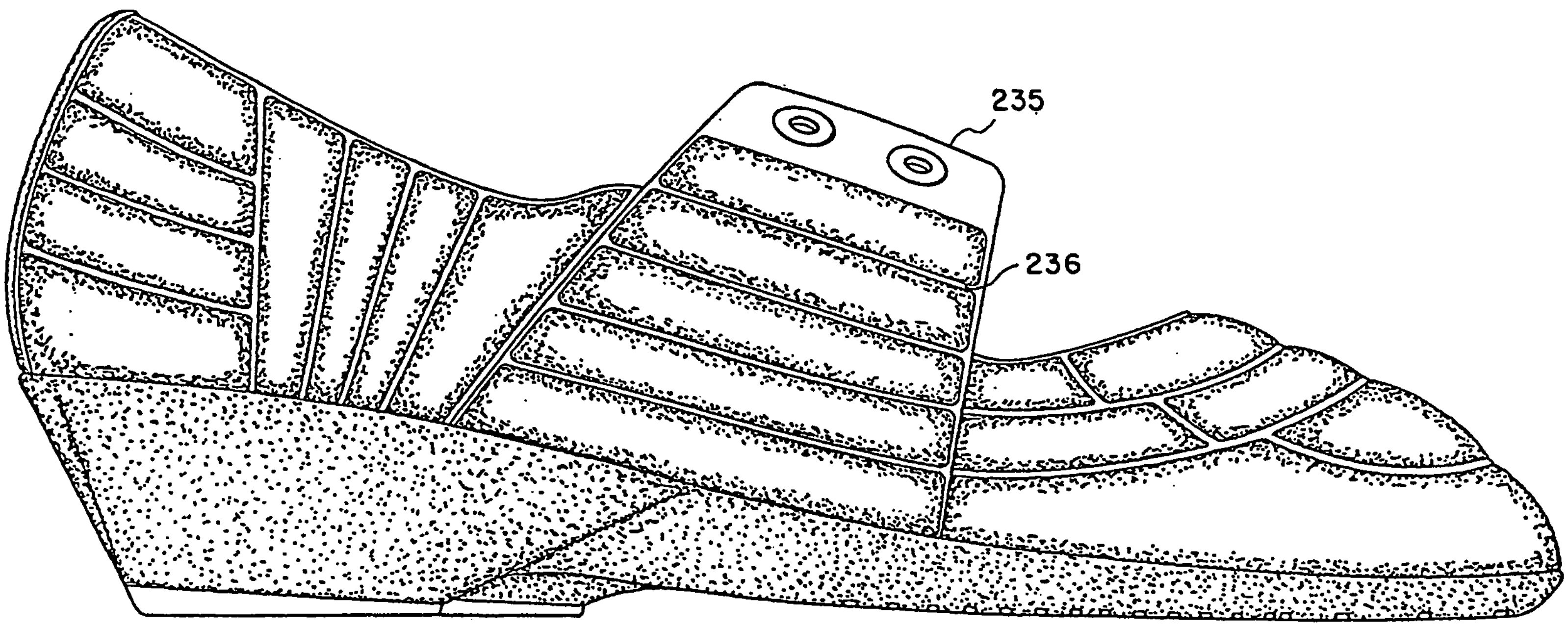

FIG. 29

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